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Exercise during Pregnancy

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EXERCISE DURING PREGNANCY

by

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This Independent Study, submitted by Sue Merkel in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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ABSTRACT

Physical fitness and sports participation has increased in popularity over the years. This raises concerns as to whether exercising while pregnant is beneficial or harmful to the mother and her unborn child. Research has determined the maternal and fetal responses during various forms of exercise. This research has been used to help establish guidelines and recommendations for pregnant women. However, there continues to be controversy as to the exercise guidelines pregnant females need to follow. Women experience physical changes throughout their pregnancy which can lead to low back pain, abdominal or pelvic floor dysfunctions. These complications can be prevented or alleviated through modified exercises designed for pregnant females. The purpose of this literature review is to analyze the maternal and fetal responses of prenatal exercise, to determine exercise guidelines for pregnant females, and to establish exercises women can perform to help minimize complications from physical changes during pregnancy.

CHAPTER 1

INTRODUCTION

In today's society, people are encouraged to be physically fit. It is estimated that 85 million Americans participate in an exercise program of some type and 25 million jog regularly.[1] A large percentage of this population is women of the reproductive age. Over the years opportunities have risen dramatically for women in sports and physical fitness. There continues to be an increase in the number of females participating in sports, both recreational and competitive. With this increase in sports participation and interest with maintaining physical fitness, there has become a concern with exercising during pregnancy. Many questions have arisen. What responses will the mother and fetus have to maternal exercise? Will exercise be safe and beneficial to the mother and her unborn child or will it have adverse effects? When can the female exercise and at what parameters, if any, should she follow to ensure an uncomplicated pregnancy? Are there specific exercises the female can perform during pregnancy to alleviate complications throughout her pregnancy, during labor, and in the postpartum phase? Research has been conducted to help answer these questions.

In the past, women were advised to refrain from exercising while pregnant due to the uncertainty of dangerous effect to the fetus and possible complications

including miscarriages, premature deliveries, complicated labors, and infant disorders.[2] Since then vast amounts of research have been conducted to determine the effects of prenatal exercise on the mother, fetus, and labor. These studies include the maternal effects of exercise on the musculoskeletal, thermoregulatory, cardiovascular and respiratory systems. Fetal responses to exercise have also been examined in the areas of heart rate, birth weight, thermoregulation, uterine activity, and blood flow. When deciding whether a female should exercise, it is important to weigh the advantages and disadvantages of exercise and keep in mind that the exercise program needs to be individualized. The American College of Obstetrics and Gynecology (ACOG) has suggested specific exercise guidelines, recommendations, and contraindications based on research to help with these decisions.[3,4]

Pregnancy affects the female's body in many aspects. During pregnancy, the female body goes through many physical changes and stresses. Exercises have been specifically designed to help prevent or alleviate complications that may occur from these changes.[5,6] The abdominal and pelvic floor muscles are the key areas to target. These exercises prepare the female for labor and delivery along with increasing the speed and ease of her body returning to the pre-pregnancy state following delivery.

This literature review will consist of information on the effects of prenatal exercise on the mother and fetus to determine whether exercising is beneficial or harmful, guidelines for exercising while pregnant, and specific exercises designed

to help the female body cope with the changes her body encounters during pregnancy.

CHAPTER 2

MATERNAL AND FETAL RESPONSES

Maternal Responses

The female body goes through many physiological changes as the pregnancy progresses which can be divided into four different categories. These categories include musculoskeletal, cardiovascular, thermoregulatory, and respiratory changes. Physiological changes that occur in a normal pregnancy can affect the maternal response to exercise along with type of activity and parameters she is able to participate at.

Musculoskeletal

The musculoskeletal system adjusts to pregnancy due to the physiological changes that occur. How the musculoskeletal system adjusts can be contributed to fetal growth in the uterus, breast enlargement, overall body weight gain, and hormonal changes which result in ligament laxity. As the fetus develops, the female's center of gravity shifts anterior and superior causing an increase in lumbar lordosis and an anterior tilt of the pelvis.[7] Balance will be re-established by a compensatory backward shift of the upper body creating an increase in thoracic kyphosis. The knees will also hyperextend to compensate for the change in the line of gravity.[8] As the breasts enlarge the cervical spine will go into

flexion causing a forward head, the scapula will protract, and the upper extremities will internally rotate to accommodate the increase in weight. [8,9] The spinal changes, the increase in lumbar lordosis, thoracic kyphosis, and forward head and shoulders, along with an increase in ligament laxity can cause great strain on the spine and sacroiliac joints.[7] During fetal development, the female's body must adjust to the enlarged fetus making more room for it to grow. Rib expansion occurs to allow for the increasing size of the fetus.[10] The diaphragm will also move in a superior direction.

Along with skeletal adjustments, muscular changes occur during pregnancy. As the uterus enlarges, the abdominal muscles are lengthened, decreasing their ability to maintain the pelvis in a neutral position which will result in an increase in anterior pelvic tilt and lumbar lordosis.[7]

In approximately thirty percent of pregnant women, a separation of the rectus abdominis muscles at the linea alba midline will occur.[11] This separation, called diastasis recti, may decrease the ability of the already lengthened and weakened abdominal muscles to support and protect the fetus. It will also limit the ability to control the pelvis and lumbar spine which will result in an increase in anterior pelvic tilt and lumbar lordosis. Because of the decreased pelvic and lumbar control created by diastasis recti, the individual will be at a greater risk for low back pain. Specific exercises can be prescribed to alleviate this problem along with exercise modification which will be discussed in Chapter four.

Muscular changes occur as a result of the altered posture experienced during pregnancy. The anterior tilt of the pelvis resulting from the additional weight of the uterus will result in shortening of the hip flexors and lumbar paraspinals which will also accentuate the lumbar lordosis.[7] The piriformis will also shorten and can result in an abnormal gait pattern which will increase abnormal stresses on the hips, knees, and ankles.[7] The rhomboids and lower trapezius muscles will lengthen and the pectoralis major and minor, teres minor, suboccipitals, levator scapulae, and scalenes will shorten causing the scapula to abduct and contribute to forward head and shoulders along with a compensatory thoracic kyphosis. These muscular imbalances can result in poor standing posture and an increased rate of muscle fatigue.

As a normal pregnancy progresses, the individual should gain between 20-35 pounds [8,12] or approximately 10-25% of her weight [9] depending on her weight and if she is under, over or at her desired weight. The enlargement of the breasts and uterus, development of the fetus, placenta and amniotic fluid, the increase in blood, muscle and fat, and the retention of fluid all contribute to the weight gain. This weight gain will add stress to the lax ligaments. The stress may be abnormal depending on the individuals posture, whether it is good or poor.

The pelvic floor muscles must withstand the increased weight exerted on them by the growing fetus and uterus. The pelvic floor drops as much as one inch by the end of the pregnancy.[8] While this has no effect on the individual's posture,

it will decrease the strength of these muscles and can result in pelvic floor dysfunction. This will be discussed in greater detail in Chapter four.

During pregnancy, alterations in hormone production occurs.[13] An increase in various hormones will affect the musculoskeletal system. Relaxin, a hormone produced during the menstrual cycle, will be produced in large amounts during pregnancy. Relaxin will soften soft tissue and ligaments throughout the body. Relaxin will greatly affect the pelvic region since the pelvis must have some laxity to allow room for the fetus during pregnancy and delivery. However, since relaxin affects ligaments and soft tissue throughout the body it can increase the susceptibility to injury.

Musculoskeletal changes that occur throughout pregnancy can greatly affect an individual's ability to exercise and her exercise program. Her altered posture which can place abnormal stress on already hypermobile joints and lax ligaments will be accentuated by weight bearing activities such as running, walking, or racquet sports. These increases in altered stresses can enhance the susceptibility to injury. The muscular imbalances that occur will make it even more important to perform a proper warm-up and cool down which includes stretching to prevent muscular injury such as muscle spasms, strains, and muscle soreness. She may develop muscular fatigue more quickly since the altered posture will increase the work required by various muscles. Many women experience low back pain and sacroiliac joint pain resulting from the altered posture. This pain can hinder activity, however strengthening exercises can

eliminate or prevent some of these musculoskeletal problems. The altered center of gravity and increased weight will alter balance and ability to shift weight making previously performed tasks more difficult. This may require an alteration or change in activity. The increased weight may hinder a pregnant woman's ability to exercise at previous levels of intensity and require that she decrease her intensity or discontinue exercising as the pregnancy progresses.

Cardiovascular

Cardiovascular adaptations occur during pregnancy that could affect a female's ability to perform exercise, especially at a higher exercise level. These changes are the circulatory systems way of compensating for the body's normal changes during pregnancy. First, blood volume progressively increases 35-50 % (1.5-2 L) throughout pregnancy and returns to normal by six to eight weeks following delivery.[8,13,14,15] Hormonal stimulation increases the plasma volume to meet the oxygen demands of pregnancy. Plasma volume increases to a greater extent than red blood cells which leads to a physiologic anemia (not a true anemia). Next, the resting heart rate gradually increases 10-20 beats per minute (bpm) above the individual's normal resting heart rate and stroke volume increases 10-12% by full term with both returning to normal by six weeks postpartum.[8,13] Cardiac output also increases 30-60% as a result of the increase in stroke volume and heart rate. Cardiac output is also influenced by body position. During motionless standing and supine lying there is a decrease in cardiac output.[4] Blood pressure decreases in the first trimester reaching its lowest level midway

through pregnancy and then gradually rising to reach pre-pregnancy level by six weeks postpartum. Blood pressure decreases due to venous distensibility and peripheral resistance. Also, heart size increases and the heart is pushed upward and to the left in the third trimester due to the elevation of the diaphragm to allow room for the growing fetus. Finally, there is an increase in distribution of blood to the visceral organs and therefore more blood flow to the uterine region.

Pregnant women demonstrate a loss in cardiovascular reserve that limits their ability to perform strenuous exercise.[15] Exercise capacity will decrease during pregnancy. Maternal heart rate has a slightly higher response to weight bearing than non-weight bearing activity during pregnancy, therefore workload (intensity) can be reduced to reach the same pre-pregnancy exercise level.[16] In other words, the female can exercise at a lower intensity than she did in the nonpregnant state and achieve the same maximal exercise capacity. Heart rate recovery after exercise is lengthened with pregnancy progression while physical recovery time remains unchanged.[17] Exercise elicits an increase in cardiac output which is greater than normal in pregnancy. This is a result of increased compression on the inferior vena cava from the enlarged uterus and a decrease in circulation reserve due to peripheral blood pooling.

Thermoregulation

Thermoregulation is defined as the balance between heat production and heat loss that is involved in maintaining thermal equilibrium.[13] Factors that need

to be considered during temperature regulation of a pregnant individual include muscular activity, hormonal and metabolic changes, and the environment.

In pregnancy the basal metabolic rate increases along with a 30-35% increase in the amount of heat generated.[4,13] With an increase in heat production the risk of maternal hyperthermia also increases. During increased muscle activity, production of heat rises which in turn will elevate core temperature. It is advisable by the ACOG not to allow maternal core temperature to rise above 38^0C.[4,17] Temperature regulation and monitoring during pregnancy is very important. Not only will maternal core temperature rise but also fetal temperature which may have detrimental effects to the fetus.

Pulmonary

Changes in the respiratory system during pregnancy are a result of hormonal and mechanical changes.[8,14] The gradual enlargement of the uterus and fetus leads to an upward movement of the diaphragm by as much as four centimeters. The transverse and anterior-posterior diameters of the thoracic chest increase by two centimeters in response to the increased intra-abdominal pressure. Flaring of the lower ribs and progressive increase in the subcostal angle also occur. The muscles and cartilage in the thoracic trunk relax and total chest circumference increases five to ten centimeters.

Progesterone levels progressively increase throughout pregnancy.[13] Progesterone alters ventilation through direct stimulation of the respiratory center.

It helps decrease airway resistance by as much as 50%, reducing the effort of breathing and enhancing airflow.

During pregnancy the resting oxygen requirement increases 10-20%.[4,8,14] The increase in effort required to breathe results from the physical changes that occur as a result of fetal and uterine growth. A decrease in oxygen is available for aerobic activity. There is an increase in tidal volume by 20-40%. Minute ventilation will also increase but total lung capacity remains unchanged or decreases slightly.

Fetal Responses

Not only does the pregnant female have altered responses to exercise, but so does the fetus. These responses include cardiovascular, thermoregulatory, and environmental. It is important to understand fetal responses to exercise in order to determine appropriate exercise participation and setting parameters.

Thermoregulation

The fetus is unable to independently control his/her temperature. A maternal-fetal thermal gradient exists which links maternal temperature to fetal temperature. Under normal conditions fetal temperature is 0.5-1.0 ^{0}C greater than maternal temperature.[4,13] This temperature gradient facilitates heat transfer to the mother from the fetus, regulating the fetal temperature. When maternal core temperature rises and heat production increases during exercise, fever, or hot environments, the temperature gradient reverses and fetal temperature will rise. Uterine blood flow decreases during exercise to increase circulation to the

exercising muscles. This will also limit the ability of the fetus to dissipate heat and therefore control fetal temperature. Animal studies have demonstrated that moderate to strenuous exercise causes uterine blood flow to decrease as much as 40%.[17] A rise in fetal temperature can be detrimental to the fetus. A 1.5 ^{0}C rise in temperature tends to stop neural cell growth, and an increase of 3 ^{0}C can kill these cells. [19] It is recommended by the ACOG that maternal core temperature not rise above 38 ^{0}C to prevent the risk of neural development deficits especially during the first trimester when neural tube development is occurring.[4]

A return of fetal normal temperature lags behind the return of maternal normal temperature since amniotic fluid provides some insulation and heat exchange of the placenta may be compromised. [16,19]

Fetal Growth

It has been recognized that infants of heavily working or exercising mothers have a birth weight reduction averaging 300-350 grams and up to 500 grams below sedentary women.[4,20] This decrease in birth weight is not substantial to have deleterious effects on the newborn. The primary reduction in birth weight is a decrease in subcutaneous fat on the infant.[4] The incidence of intrauterine growth retardation with maternal exercise is unknown.[9] A combination of inadequate diet and strenuous exercise may lead to decreased intrauterine growth. Women who exercise in the third trimester are also more likely to have preterm babies. In a study by Clapp,[21] high intensity exercisers delivered four days

earlier, had a shorter labor by approximately two hours, had a low cesarean section rate, and smaller babies.

Fetal Heart Rate

The most commonly analyzed fetal response to maternal exercise is fetal heart rate (FHR) because it is an indicator of fetal well being.[22] FHR typically accelerates during and after maternal exercise with the magnitude of response dependent on gestational age along with intensity, type of exercise, and duration of exercise.[16,22,23] Average FHR is 155 beats per minute (bpm) at 20 weeks, 144 bpm at 30 weeks, and 140 bpm at term.[13] Variations of 20 bpm above or below these levels is considered normal. Maternal exercise is associated with an increase in FHR by 10-30 bpm followed by a gradual return to resting heart rate 15-30 minutes following exercise.[8,9,20] The exact mechanism for the increase in fetal heart rate in unknown. Several possibilities exist including increase in fetal activity or wakefulness, increase in fetal temperature, decrease in uterine blood flow resulting in a decrease in oxygen supply (hypoxia), or increase in fetal sympathetic activity.[9,16,20,24]

Fetal bradycardia (less than 120 bpm) may occur in response to maternal exercise, yet its occurrence is rare.[13] The most common onset of fetal bradycardia is within two to three minutes of discontinuing exercising. The onset and recovery from fetal bradycardia are faster and a compensatory tachycardia may occur.[22] Fetal bradycardia is more likely a result of maximal maternal exertion than moderate intensity. Fetal bradycardia is most often a distress sign. It has

been linked to cord compression, uterine hyperactivity, maternal dehydration, congenital cardiac problems, and fetal hypoxia.[9,20,22]

CHAPTER 3

EXERCISE GUIDELINES AND RECOMMENDATIONS

Exercise Advantages and Disadvantages

Exercising while pregnant can have advantages and disadvantages for both fetus and mother.[5,25] Exercising can maintain maternal fitness and increase stamina and strength needed for the intense demands during labor and delivery and reduce the chances of complications. Exercise will increase energy level during pregnancy enhancing physical and psychological well-being. Reduction of symptoms related to pregnancy may occur including relief of low back pain, leg cramps, edema, breathlessness, fatigue, heartburn, and constipation. Specific exercises to target pelvic muscles (pelvic muscle exercises or Kegel exercises) will prevent pelvic organ prolapse, urinary incontinence, and minimize damage to the pelvic muscles during delivery. Strengthening the abdominal muscles will minimize risk of diastasis recti and alleviate low back pain. Exercise will help the female avoid excess weight gain during pregnancy, and enable her to recover more quickly from pregnancy and delivery. Exercise can also enhance fetal well-being by stimulating the fetus. Exercise has a lifelong conditioning effect on the fetus as well.

On the other hand, there are disadvantages to exercising during pregnancy.[5,25] With exercise there is an increased risk of maternal musculoskeletal injury secondary to changes the body endures throughout pregnancy such as increased weight gain, altered center of gravity, decreased balance and coordination, and ligamentous laxity. A decrease in uterine blood flow will occur during exercise to supply blood to the exercising muscles, limiting oxygen and nutrients to the fetus. Maternal core temperature rises during exercise which places the fetus at risk for hyperthermia, possible neural tube damage or brain damage, especially in the first trimester. Risk of maternal and fetal hypoglycemia is also apparent with prolonged exercise; glucose is essential for fetal growth therefore the mother must consume extra calories. Endocrine homeostasis and partitioning of energy expenditure is affected. There is also a possibility of lighter birthweight, however this is largely due to decreased subcutaneous fat.

General Guidelines

As soon as a female becomes pregnant, it is important to obtain a medical and obstetrical evaluation prior to initiating an exercise program or continuing an exercise program. Before approving an exercise program, a physician will need to understand the history of the patient's cardiovascular, pulmonary, metabolic, and musculoskeletal systems along with a history of prior pregnancies. Physical fitness level prior to pregnancy should be evaluated; the intensity and duration the individual was previously exercising at will help determine what level she should

exercise at during her pregnancy. From this data, the physician may individualize the exercise program based on the woman's health status and any complications she may be experiencing.

Several contraindications to exercise during pregnancy exist and are listed in Table one. Additional contraindications may exist based on the physician's evaluation and findings. Females with any of these contraindications should refrain from initiating their own exercise program. A strict physician supervised exercise program may be beneficial to alleviate some of the symptoms women may experience from the complications. There are also many precautions to prenatal exercise that exist which physicians, health care professionals, and pregnant females should be aware of. The precautions are listed in Table two. If any of these precautions do exist during pregnancy, the exercise program may need to be strictly supervised and modified. Many of these women may benefit greatly from a supervised exercise program.

Pregnant females need to be educated to recognize signs and symptoms of overdoing an exercise program. They need to understand the changes their body goes through as their pregnancy progresses and how this affects their ability to perform and participate in an exercise program. It is important for pregnant women to recognize these signs, discontinue exercising and contact a physician if they occur. These signs and symptoms are listed in Table three.

Through research, maternal and fetal responses to exercise have been examined. Based on this research, specific exercise recommendations and

Table 1. Contraindications to Exercise [2,8,9,11,18,26,27,28]

1. incompetent cervix
2. vaginal/ uterine bleeding
3. placenta previa
4. membrane rupture with amniotic fluid loss prior to labor onset
5. premature labor prior to 37th week
6. maternal heart disease
7. pre-eclampsia
8. thromboplebitis
9. acute infectious disease
10. intrauterine growth retardation or macrosomia
11. recent pulmonary emoblism
12. severe isoimmunization
13. no prenatal care
14. suspect fetal distress
15. history of complicated pregnancy
16. postdatism
17. threatened abortion
18. thyrotoxicosis
19. history of more than one miscarriage
20. anticoagulation therapy
21. cervical cerclage
22. smoke while pregnant

(Pregnant women should not exercise if they have any of these conditions.)

Table 2. Precautions to Exercise[8,28]

1. multiple gestation - exercise may precipitate uterine contraction
2. anemia - decrease oxygen carrying capacity
3. systemic infection
4. extreme fatigue
5. musculoskeletal complications/ pain
6. overheating
7. phlebitis
8. diastasis recti
9. uterine contractions (last several hours after exercise)
10. history of sedentary lifestyle
11. hypertension
12. maternal diabetes
13. excess obesity or extremely underweight
14. breech presentation in third trimester
15. thyroid disorder
16. blood disorder

(These females need close doctor / therapist supervision and may need exercise modification.)

Table 3. Signs and Symptoms to Discontinue Exercising and Contact Your Physician[8,28]

1. pain
2. bleeding (vaginal)
3. short of breath
4. irregular heart beat
5. dizziness
6. faint/ nausea
7. tachycardia/ palpitations
8. difficulty walking
9. back/ pubic pain
10. decreased fetal activity
11. uterine contractions (15 minute interval or more frequent)
12. general edema
13. numbness of any body part
14. chest pain

(If any of these symptoms or warning signs occur before, during, or after exercise, the female should stop exercising and contact her physician.)

guidelines have been established for the pregnant female to prevent adverse effects to either the mother or unborn child. There is also evidence supporting the importance or advantages of exercising while pregnant along with research refuting these advantages. The expectant mother and her physician should determine the degree of participation in an exercise program, the type of program, and adherence to these guidelines.

The following are guidelines set by the American College of Obstetrics and Gynecology (ACOG) in 1985[3] and updated in 1994.[4] Other associations such as the American College of Sports Medicine (ACSM) and researchers in the area of prenatal exercise have developed additional exercise recommendations which have been included.

Temperature

It is important to avoid overheating during exercise since this may have detrimental effects to the fetus. Maternal core temperature should not exceed 38 °C (100.4 °F).[3,4,17,26] There are many precautions to take to ensure that overheating and hyperthermia do not occur. First, activities should not be performed in hot, humid weather or in low oxygen environments. Second, proper clothing (lightweight, cotton, loose fitting) should be worn. Also, consuming plenty of water before, during, and after exercise to avoid dehydration is essential. A pregnant woman has a greater risk of dehydration than a non pregnant female. Finally, avoid hot tubs, warm pools, and saunas where it is more difficult to dissipate heat; maternal hyperthermia can result which could cause birth defects

such as neurological deficits especially in the first trimester when the neural tube is developing.[26]

Nutrition

Pregnancy is not a time to initiate a weight loss program. Twenty to thirty five pounds should be gained by the female in a normal pregnancy.[12] Pregnancy requires an additional 300 kcal per day to maintain metabolic homeostasis and 500 kcal per day if exercising while pregnant depending on the type and level of activity.[4] Prolonged exercise may cause fetal and maternal hypoglycemia.[2] Glucose is essential for fetal growth. It is important to consume extra calories while pregnant to maintain metabolic homeostasis, to have adequate energy for exercise, and to ensure the fetus is adequately nourished.

Intensity and Duration of Exercise

Pregnancy fitness level should not exceed pre-pregnancy fitness level.[8] Regular exercise (at least three times per week) is recommended over intermittent activity and competitive activities should be discouraged.[4] As pregnancy progresses, be aware of a decrease in oxygen level available for aerobic exercise. Exercise intensity and duration should be modified according to maternal symptoms.

Intensity of exercise can be determined by heart rate which should be monitored during exercise. Target heart rate should be measured at peak performance. Maximum heart rate should be determined by pre-pregnancy level according to fitness and age. In 1985, the ACOG had set standards that target

heart rate should not exceed 140 beats per minute.[3] In 1994, this limitation was withdrawn because it did not take into account each individual's characteristics such as fitness condition and age which can affect how hard an individual is able to exercise.[4,12] Now the ACOG sets no limitations on heart rate but encourages modifying the intensity to maternal symptoms and not exercising to exhaustion. Artal[9] states that to maintain cardiac fitness during pregnancy a heart rate of greater than 140 beats per minute is not needed because as pregnancy progresses less energy is needed to reach maximum heart rate. Pregnancy induces a state of hypervolemia which is defined as an abnormal increase in the volume of circulating blood.[27,30] Cardiovascular changes that result from hypervolemia create a training effect.[27] Therefore the female does not need to exercise at the same intensity level prior to pregnancy to get the same workout.

The ACSM uses the RPE (rate of perceived exertion) or Borg scale to measure the exercise peak intensity of a pregnant female.[17,27] The Borg scale is based on a person's self perception of how hard they are working or their exertion level. The scale ranges from six to twenty with six being very, very light exertion and twenty being very, very hard exertion. The rate of twelve to fourteen, which is recommended by the ACSM for the exercising pregnant female, falls between somewhat hard and hard exertion levels. This scale may be inappropriate for the pregnant female to use since it was developed on male subjects using a bicycle ergometer rather than pregnant females participating in various forms of exercise.

Duration of exercise at maximum heart rate should not exceed fifteen minutes as set by the ACOG.[3] The ACSM set guidelines that maximum heart rate should not exceed 15-30 minutes.[17] These standards have been removed because they do not take into account the female's physical fitness level and endurance and elite athletic women participating in competitive sports may be able to exercise at peak levels for longer periods of time. It is important that the female listen to her body and not exercise to fatigue or exhaustion. Heart rate and respiratory rate should return to resting within fifteen minutes after exercise.[26] If heart rate is not below 100 beats per minute ten minutes after exercise then intensity and/or duration should be decreased.[29]

Women who had sedentary lifestyles prior to pregnancy should begin slowly with very low intensity exercise such as walking and progress gradually. Many sedentary pregnant females will have difficulty distinguishing between body responses to exercise and body responses to pregnancy. It is important to educate the female on both of these responses and proper methods of monitoring heart rate, respiration, body temperature during exercise and signs of fatigue. The female should also be aware of warning signs, when to discontinue exercising and when to contact her physician. The second trimester is the best time to initiate an exercise program because the female is physically feeling well and complications can arise with exercise initiation in the first or third trimester.[31] During the first trimester, the neural tube is developing and overheating can prevent proper development of the brain and spinal cord leading to fetal disorders such as spina

bifida. During the third trimester, the mother and fetus will fight for glucose and blood flow. The mother will have decreased coordination and balance secondary to her changing body in this final trimester making her more prone to musculoskeletal injury.

With progression of the pregnancy, many females will decrease the duration and intensity of exercise, and may modify their activity level. This may be caused by increased weight, decreased coordination, balance, fatigue, and decreased aerobic capacity. Many studies have shown pregnant women to exercise at a lower intensity and shorter duration in the third trimester than in previous trimesters.[28]

Stretching

A proper warm-up which includes adequate stretching and a gradual increase in heart rate should be performed before starting to exercise.[3] Upon completion of exercising, a cool down period should be incorporated. The cool down should include a gradual decrease in heart rate and proper stretching. When stretching, it is important to remember that ligaments are more lax and the individual may feel more flexible. She should not go beyond normal physiologic range or beyond the flexibility range that was accomplished prior to pregnancy to prevent ligament and muscle injury. Stretching should be slow, avoiding quick, jerky movements. Hamstring and adductor stretching should be performed with caution since overstretching these muscles may cause hypermobility and pelvic instability.[8]

Activities to Avoid

Changes in the body during pregnancy will require the female to avoid various positions, and modify or discontinue certain activities. Certain exercises, activities, and positions should be avoided due to the increased risk of injury to the female; avoid ballistic, jerky, bouncing motions, high impact movements, and activities that require quick changes in direction, jumping, and jarring. Activities that require the valsalva maneuver or breath holding should also be avoided since this can lead to an increase in downward force on the uterus and pelvic floor and increase intra-abdominal pressure.[4,8,28]

Activities should not be performed in the supine position after the first trimester.[3,4,8] This position will cause the uterus to put pressure on the inferior vena cava causing a decrease in cardiac output. This can lead to maternal hypertension and decrease the blood supply to the fetus. A small wedge or towel roll placed under the right hip will turn the patient slightly to the left and decrease the effects of uterine compression on the inferior vena cava.[8] It is also important to avoid prolonged periods of motionless standing since this can decrease cardiac output to a greater extent than supine lying. A gradual rise from the floor should be performed to prevent orthostatic hypotension.

The prone position will need to be avoided in the later stages of pregnancy when the abdomen protrudes forward. This position can be very uncomfortable for the female and may place unnecessary pressure on the abdomen possibly injuring the fetus who is no longer protected by the pelvis. In the prone

position, avoid the knee-to-chest position with the buttock elevated above the chest if at risk of bleeding or experiencing symptoms of early placental detachment.[8] An air embolism can occur when the buttocks are elevated and the uterus moves superiorly since pressure changes cause air to be sucked into the vagina and uterus where it can enter the circulatory system through an open placental wound.

Use caution when performing exercises in the "fire-hydrant" position which is done on all fours (four point or hands and knees) with the hips and knees bent to 90 degrees and the hip is then abducted out to the side.[8] This exercise is safe as long as the hip is not abducted past the physiological range of motion. Hip abduction past this range can cause sacroiliac joint compression. Caution should also be used when performing hip extension in the four point position. The leg should be elevated only until it is in line with the trunk; if elevated past this point low back pain can occur. In the four point position, increased abdominal weight from the enlarged fetus and uterus will place stress on the low back causing the back to arch forward towards the floor, predisposing the female to possible back pain.

Unilateral weight bearing activities should be avoided.[8] With the majority of weight on one leg and the pelvis tilted there is a greater risk of sacroiliac dysfunction especially with the addition of ligament laxity in the pelvic region. Unilateral weight bearing can also cause balance problems due to the altered center of gravity and increased weight in the abdominal region.

Pregnant females should avoid full sit-ups, deep knee bends, straight leg toe touches, and bridging in the supine position.[4,9,29] Bilateral straight leg raises should not be performed because it places increased stress on the abdominal muscles and can cause diastasis recti or back pain and injury. Deep flexion or extension of joints should be avoided because of increased laxity in the connective tissue. Vertical push-ups (such as against a wall), head curls, side lunges, fencers forward lunge, and leg slides could be performed instead.[9]

Sports

Sports, both recreational and competitive, are an important part of many females' lifestyles. Once pregnant, the woman needs to decide whether to continue participating in these sports at her previous level, discontinue participation, or modify the activity through a decrease in intensity, duration or competitiveness. It is recommended that women discontinue competitive participation in sports when they become pregnant due to the uncertainty of maternal and fetal risks and increased risk of injury as pregnancy progresses due to physiological changes. Many women opt to discontinue performing at a competitive level and will reduce exercise duration and intensity levels on their own as their pregnancy progresses.

Sports that have the potential of being harmful to the mother and/or fetus are discussed below with recommendations to modify or discontinue the activity. Exercises that have beneficial effects are also discussed.

Skiing

Pregnant women should not participate in water skiing.[2,11] As pregnancy progresses, changes in the body's center of gravity and a decrease in coordination can increase the risk of falls. Forceful entry of water into the uterus which can occur during a fall can also cause a miscarriage. Downhill skiing is discouraged due to increased risk of injury from collisions and falls.[2] This could injure the mother and/or the fetus depending on the mechanism of the fall or collision. Cross-country skiing can still be performed. As pregnancy progresses, it may be necessary to modify or discontinue the activity because of decreased balance and coordination.

Scuba Diving

Scuba diving should be avoided due to the risk of decompression sickness, nitrogen bubbles, hyperoxia (increased levels of oxygen in the blood), hypoxia (deficiency of oxygen due to decreased concentration of oxygen in inspired air), hypercapnia (high amount of carbon dioxide in the blood), and asphyxia (condition caused by insufficient oxygen intake).[2,11,28,30] There is also potential for development of intravascular air embolism in the fetus and fetal anomolies with deep dives. A risk of being attacked by marine animals with poisonous venom which can harm both the mother and fetus is evident.

Horseback Riding

Horseback riding is contraindicated during pregnancy.[2] Ligamentous structures become lax as a result of the increased production of relaxin. The bouncing movements during horseback riding will increase the stress placed on

the ligaments, especially the pelvis, which can lead to injury. One such injury is osteitis pubis, a painful inflammation of the connective tissue at the pubic symphysis, characterized by pain and muscle spasms at the symphysis pubis and an unstable gait.[7] The pregnant female also is at risk of falling, causing abdominal trauma and/or injury to the fetus.

Contact Sports

Pregnant women should discontinue or use extreme caution when participating in contact sports such as basketball and sports with an increased risk of abdominal trauma such as football, boxing, hockey, and soccer.[18] They should also avoid activities that require an anaerobic pace and ballistic movements. Caution should be taken when participating in activities that require good balance and coordination. As pregnancy progresses, the female's weight gain will alter her center of gravity making it more difficult to perform the same balance and coordination activities she was involved in before her pregnancy.

Bicycling

Cycling is an excellent non weight bearing activity that will limit stress placed on joints and lax ligaments.[2,26,28] However, as the pregnant female's center of gravity shifts anterior with the increased weight in the abdominal region, she may be at an increased risk of low back pain. The increased abdominal weight will enhance the lumbar lordosis which will be accentuated when the female leans forward to grasp the handle bars. A risk of falling is also evident due to a decrease in balance and riding on altered terrain. Use of a stationary bicycle is

encouraged as the pregnancy progresses to alleviate the risk of falling.[2] Balance will be better maintained since there is no need to make turns and the individual is not riding on uneven terrain. Stationary bicycling will also limit the lumbar lordosis and prevent low back pain since the female will not need to lean as far forward to grasp the handle bars.

Racquet Sports

Racquet sports such as tennis and racquetball should be discouraged in pregnancy unless the individual participated in the sport prior to becoming pregnant and is accustomed to the activity.[12] These sports should be performed with caution and on a less competitive basis due to the altered center of gravity and decrease in balance and coordination which can make sudden directional and weight shift changes required in most racquet sports difficult.

Weight Training

Weight training strengthens the muscles and can therefore enable the pregnant female to better cope with changes in posture, center of gravity, and additional weight that occurs during pregnancy. In addition, it can help decrease pain and muscle soreness in postpartum when carrying the newborn. Pregnant women can continue weight training as long as their goal is to maintain strength.[2,28] Low repetitions with low weight is recommended. Utilization of proper breathing techniques is important.[2,8,32] Breath holding and the valsalva maneuver should be avoided since these can lead to an undesirable downward force on the uterus and pelvic floor. The valsalva maneuver can also decrease the

oxygen supply to the placenta and compromise the fetus. Proper body mechanics are essential to prevent added strain to lax ligaments and joints. Exercises that can strain the low back such as bent row, squats, and dead lift should be avoided.[11]

Running

Jogging is not an exercise to initiate during pregnancy.[15] Because of nausea, vomiting, and fatigue that is prevalent during pregnancy, women may not be able to run long distances. During the second and third trimesters, increased body weight may make running more difficult. Performance may be affected by joint laxity, varicose veins, and lower limb edema. Coordination may be impaired making it difficult to run on altered terrain. Many women may wish to decrease their running distance as their pregnancy progresses. In a study conducted on self-determined running distances of pregnant subjects, it was found that a reduction in distance occurred in the later stages of pregnancy.[15] Reasons for the decrease in distance were discomfort, decreased aerobic capacity, and fatigue. The female should listen to her body, monitor fatigue level, heart and respiratory rate, and body temperature when choosing the running distance. To prevent injury from hyperthermia and dehydration, it is advised to reduce running distance to no more than two miles per day. For women who are unable to run or wish to discontinue their running program a brisk walking program of four to six miles may be an alternative.[15]

Aquatic Exercise

Swimming and water aerobics are highly recommended activities to participate in while pregnant.[2,17,29,31,33,34] Aquatic exercise utilizes various properties of the water such as hydrostatic forces, thermoregulatory properties, and buoyancy which may provide advantages over land based exercises for pregnant females.

Aquatic exercise can be very beneficial for reducing edema, a common problem among the pregnant population. This is accomplished through the water's hydrostatic and diuretic properties. Hydrostatic pressure is the pressure exerted on an immersed body by the water.[35] Hydrostatic pressure exerts a force proportional to the depth of immersion. A pressure gradient developed by this pressure puts greater pressure on distal portions of the body, specifically the feet and legs where there is more edema, pushing it to more proximal areas of the body, and decreasing edema. This pressure also pushes extravascular fluid, which causes edema, into the intravascular space.[21] Water also has a natural diuresis property which helps to reduce water retention. Pregnant women immersed in water for 20-40 minutes have shown to have a fluid loss of 300-400 ml.[35]

A pregnant female's thermoregulatory system is often altered. Pregnant women will produce more heat and may have increased difficulty dissipating heat during exercise which can result in overheating and possibly hyperthermia leading to detrimental effects for the fetus. Water conducts heat approximately 25% faster than air therefore the female's core temperature rises slower when exercising in the water than on land.[35] This decreases the risk of overheating and hyperthermia.

The water's temperature must be taken into consideration. If the female exercises in warmer water, she will not be able to dissipate heat as well. Studies have shown that water temperatures of 80-83 ^{0}F is optimal so that the exercising female can continue to dissipate heat.[29,33,34] Water temperatures greater than 101^{O}F can cause neural damage to the fetus especially in the first trimester when the neural tube is developing. Therefore, hot tubs and high temperature pools should be avoided.

Water exercise is also an excellent non-weight bearing activity because of the water's buoyancy properties. Buoyancy is defined as the upward force of the water acting on a body or object that creates an apparent decrease in weight of the body or object.[35] The body's increase in weight during pregnancy can cause great amounts of stress on the joints and lax ligaments. Water allows women to exercise without creating extra stress on the joints from the increased weight. The water also allows the female to assume the prone position in the later stages of pregnancy which she will not be able to do on land because of her enlarged abdomen.[31] The prone position is beneficial since it promotes blood flow to the uterus.

While aquatic exercise is beneficial, precautions must be taken if a pregnant female wants to continue or initiate a swimming program. Diving and jumping into the pool should be avoided, especially after the first trimester when the fetus is no longer protected by the pelvis.[2] Women with ruptured membranes

should stay out of the swimming pool due to the risk of infection.[34] Women should also avoid warm pools and whirlpools.

CHAPTER 4

SPECIFIC EXERCISES

Due to the musculoskeletal changes that occur during pregnancy, many women are prone to developing dysfunctions of muscular alignment and strength. Often the areas most affected are the abdominal muscles and the pelvic floor. Exercises can be performed to help prevent such problems. These exercises have also been proven to alleviate symptoms and correct the dysfunction.[6,8]

Diastasis Recti

Diastasis recti is defined as a painfree condition involving a separation of the rectus abdominis muscle as a result of widening of the linea alba.[6,8,36] The linea alba extends from the sternum to the pubis. It is formed by a fusion of the right and left aponeuroses of the abdominal muscles including the rectus abdominis, internal obliques, external obliques and transverse abdominis. The occurance of diastasis recti is estimated at 30% prenatally [11] and 50-60% postnatally.[37] However, literature suggests that diastasis recti among the pregnant population may be more frequent than expected.[37,38]

Normally the rectus abdominis muscle bellies are two centimeters apart above the umbilicus and in contact with each other below the umbilicus.[8,36]

However, during pregnancy this width can increase causing significant problems involving posture, pain, and activities of daily living.

Etiology

The exact etiology of diastasis recti in the pregnant population is unknown, however there are many possible causes.[8,36] One possible cause is the alteration of maternal hormones during pregnancy. There is an increase in the production of relaxin during pregnancy which has been shown to soften tissues of the reproductive tract including the uterus, cervix, breast connective tissue, along with ligamentous structures and connective tissue. Relaxin may cause increased extensibility of the linea alba resulting in diastasis recti.

Diastasis recti is also thought to result from structural alterations.[6,36] The increasing size of the fetus and uterus places strain on the linea alba which may separate as a result. Displacement of the abdominal contents resulting from the increased size of the fetus and uterus can place even greater stress on these structures. The rib cage will expand approximately two centimeters in the anterior-posterior and transverse diameters which may also place increased strain on the linea alba. In a study by Boisssonnult,[38] the incidence of diastasis recti increased with progression of pregnancy. Diastasis recti was first noted in the second trimester and peaked in the third trimester. The incidence was less frequent in the postpartum period than the third trimester but was still prevalent.

Abdominal muscle lengthening and weakness may also cause diastasis recti to occur. Kendall[36] explains the etiology of diastasis recti in terms of stretch

weakness. The abdominal muscles are placed in an elongated position for an extended period of time due to the enlarged uterus and fetus. This prolonged elongation is beyond the physiological rest position of the abdominal muscles creating weakness of the abdominals and therefore separation of the linea alba. This excessive elongation and weakness can predispose the female to develop diastasis recti during the postnatal period.

Persistent excessive increases in intra-abdominal pressure can also lead to the development of diastasis recti.[36] Intra-abdominal pressure increases during the second stage of labor when there is an excess amount of pushing. It also increases during such activities as coughing, sneezing, voiding, lifting and straining.

The pregnant female is predisposed to development of diastasis recti if she is obese, having a large baby, has had multiple pregnancies, has excessive fluid in the uterus, has a pendulous abdomen from past pregnancies or weak abdominal muscles prior to pregnancy.[6] Various situations including lifting and carrying heavy objects, sudden strain or falls can increase the risk of developing diastasis recti.[36]

Implications

The abdominal muscles have many important functions including maintaining posture, increasing intra-abdominal pressure to decrease pressure on the spine, and protection of the abdominal contents. With pathology of the abdominal muscles, these functions can become compromised.

The development of diastasis recti can have many implications for the female during and after pregnancy.[6,8,36] The abdominal muscles will elongate and decrease in strength as pregnancy progresses. A separation of the rectus abdominis muscle at the linea alba will enhance this weakness preventing the abdominal muscles from properly functioning. The abdominal muscles normally control the alignment of the pelvis on the lower extremities and the trunk on the pelvis. With diastasis recti, the muscles are not strong enough to properly align the trunk, pelvis, and lower extremities therefore abnormal posture will develop. An increase in lumbar lordosis and an anterior pelvic tilt will occur and lead to low back pain and spinal dysfunction.

Diastasis recti can cause spinal dysfunction.[36] The decreased strength of the abdominal muscles will lead to a decrease in the intra-abdominal pressure which in turn increases the force placed on spinal discs especially in such positions as lifting and standing. This can lead to disc protrusion.

Another important function of the abdominal muscles is protection of the abdominal and pelvic viscera and the fetus. With diastasis recti, the fetus, abdominal and pelvic structures are only protected by skin, fascia, fat, and peritoneum leading to an increased susceptibility to injury.[36] In severe cases of diastasis recti, herniation of the abdominal viscera through the separation in the abdominal wall may occur.

Diastasis recti can impair the female's ability to perform activities of daily living. The primary actions of the abdominal muscles are trunk flexion, rotation,

and lateral flexion.[6,36] The inability to fully achieve these movements can hinder a person's ability to perform necessary activities such as transfers, mobility in bed, and dressing. It can also limit the ability to care for the newborn child. Many activities including voiding, defecating, coughing, sneezing, vomiting, and delivery of the fetus require an increase in intra-abdominal pressure to assist in performing these activities. The intra-abdominal pressure exerts a compression force on the abdominal viscera which aids in performing these activities; weakened and stretched muscles will not be able to increase intra-abdominal pressure.

Testing

Testing for diastasis recti can be an important part of a physical therapy evaluation or can be performed by the well educated female. It is important to detect and correct diastasis recti before initiating any form of abdominal exercises. The only way to detect this condition is to palpate the abdomen.[6,7,8,10,37,38] To test for diastasis recti, the female needs to assume the hook-lying position (supine, flexed knees). She should slowly raise her head and shoulders reaching towards her knees with her hands until the spine of the scapula is off the supporting surface. The therapist then places their fingers horizontally across the mid-line of the abdomen. If the fingers sink into a gap, a separation of the rectus abdominis is present. The separation occurs most often at the level of the umbilicus but can also occur above and below the umbilicus, therefore the palpating fingers should be placed along the entire length of the linea alba to detect a separation. The

diastasis is measured by how many fingers can be placed into the gap. Two centimeters or approximately two fingers widths above the umbilicus and one centimeter below the umbilicus is considered normal; anything greater than that is significant and requires corrective exercises before performing abdominal strengthening activities.[6,8,10,36,38] The presence of a longitudinal bulge along the rectis abdominis is also a sign of diastasis recti.

Exercises

To correct the diastasis recti, the following exercise should be performed.[6,7,8,10,36,38] The female should assume the hook-lying position with hands crossed over the mid-line at the level of the separation as though she is going to hug herself. She then needs to exhale and lift her head and shoulders until just before a bulge of the rectus abdominis appears. Then she pulls the rectus abdominis muscle bellies toward the mid-line with her hands. She then lowers her head and relaxes. This activity can be performed with a posterior pelvic tilt to increase effectiveness.[6] It is essential for the female to exhale while lifting her head and inhale during relaxation, since inhaling while tightening the abdominal muscles will increase the intra-abdominal pressure and can increase the separation.

The female can learn to test herself for diastasis recti and monitor her progression. Once initiating abdominal muscle strengthening, it is essential to frequently perform the test for diastasis recti. If the separation is increasing in size, the female is progressing abdominal strengthening exercises too quickly. If

the separation becomes greater than two centimeters, she needs to discontinue her abdominal strengthening exercises and perform the correction exercises until the separation is less than two centimeters.

If diastasis recti is evident, the female needs to modify various activities. She needs to limit activities that increase intra-abdominal pressure or brace her abdominal muscles if performing such activities. Avoiding activities that stretch the abdominal musculature is important since these muscles are already elongated. Activities that can strain the abdominal musculature must be modified or eliminated to prevent further injury.

Pelvic Floor

The pelvic floor consists of a multi-layer of muscles stretched between the pubis and coccyx and forms the inferior support of the abdominal and pelvic cavity.[8,39] The outermost layer is the anal triangle formed by the anus and external anal sphincter which controls continence of the bowel.[39] Next is the urogenital triangle that functions in sexual activity and support of the internal organs. The next layer moving inward is the pelvic diaphragm or levator ani which supports the internal organs. The smooth muscle diaphragm forms the fourth layer. This layer is composed of the internal and external urethral sphincters and controls continence of urine. The endopelvic diaphragm forms the innermost layer and is made up of fascia. The pelvic floor is pierced by the openings of the urethra, vagina, and the rectum. Sphincters are rings of muscle surrounding these openings and function in constricting to close the opening.

Function

The pelvic floor serves many functions.[6,8] The pelvic floor supports the pelvic organs and their contents, more specifically the bladder, uterus, and the bowels. There is always some degree of tone in the pelvic floor muscles that will support the pelvic organs and prevent these structures from prolapsing. Secondly, the pelvic floor withstands the increases in pressure in the abdominal and pelvic cavity. The increase in intra-abdominal pressure may be intermittent during coughing, sneezing, laughing, lifting, straining, or pushing in the second stage of labor. The pressure may also be constant such as the increased pressure placed on the pelvic floor during pregnancy from the increased weight of the uterus and fetus. The pelvic floor also functions to provide sphincter control of the perineal opening. During elimination, the pelvic floor relaxes and upwardly contracts to return the pelvic floor muscles to the supportive position. The final function of the pelvic floor muscles is in reproduction and sexual activity.

Dysfunction

If any of these functions is disrupted, a pelvic floor dysfunction will result. Two main problems of the pelvic floor are urinary stress incontinence and organ prolapse. Approximately 46% of pregnant females complain of urinary incontinence.[40] The International Continence Society defines incontinence as the loss of urine that is unacceptable to the individual.[39] It results when the pelvic floor does not support the bladder during times of increased intra-abdominal pressure. The bladder neck descends and the urethra does not adequately close

due to weakness of the sphincter resulting in uncontrolled urine loss. In pregnancy, the fetus puts pressure on the bladder enhancing the problem. The second problem that can occur is prolapse of the pelvic organs. Normally the pelvic floor supports the pelvic organs, however, should this support weaken such as in pregnancy, the gravitational forces will draw the pelvic organs downward creating problems in the organ's ability to function.

Etiology

Pelvic floor dysfunction can have a wide variety of causes.[6,8,39,40] Normally the pelvic and abdominal organs and the force of gravity put stress on the pelvic muscles. However, during pregnancy there is an even greater strain exerted on these muscles because of the increased weight of the fetus and uterus. This will cause a downward force on the muscles. It is estimated that the pelvic floor drops one inch during pregnancy.[8] Muscle laxity and weakness, especially of the levator ani muscle, can also predispose the female to pelvic floor pathology. Laxity can result from the increased production of relaxin causing a softening of connective tissue and ligaments. Prolonged increased weight exerted on the pelvic floor muscles from the fetus and lack of exercise to the muscles result in weakness and eventually prolapse of the pelvic organs. Intra-abdominal pressure increases throughout pregnancy due to the enlarged fetus and uterus. Intermittent increases in pressure in the abdominal cavity from such activities as sneezing, coughing, straining, and lifting can strain the pelvic floor. Trauma to the pelvic floor during labor and delivery may occur; a prolonged second stage of labor

(greater than one hour), use of forceps to speed the delivery process, an episiotomy to prevent overstretching the pelvic floor, and pudendal nerve damage during labor have been associated with pelvic floor dysfunction.[40] Today, the average birth weight of babies is greater secondary to better prenatal care and nutrition. The larger baby can damage the pelvic floor by overstretching or tearing the muscles or interrupting the nerve supply.

Exercises

Pelvic floor dysfunctions can be alleviated or prevented by exercising the pelvic floor musculature. Pelvic muscle exercises (PME) otherwise known as Kegel exercises were developed in 1948.[41,42] These exercises involve voluntary contraction and relaxation of the band of muscles that form the loops around the vaginal and urethral openings.[42] These exercises are very beneficial in strengthening the pelvic floor muscles, alleviating and preventing symptoms from pelvic floor dysfunction, and learning to relax the muscles to allow passage of the fetus during delivery.

PME are performed by contracting the muscles at the side of the pelvic floor upward and toward the midline. This creates a squeezing and lifting effect. Squeezing the sphincters and elevation of the inside passageways work together and create a muscle contraction of the entire pelvic floor musculature. Contraction of the pelvic floor muscles is followed by relaxation of the muscles.

Pelvic muscle exercises should be initiated in the supine position so that the muscle contraction is not against gravity and makes the contractions easier to

perform. The female should progress to sitting and standing positions when the contractions become stronger and easier to perform. Small cone shaped weights inserted into the vagina can be used to apply resistance to the contraction. The goal is to contract the pelvic floor muscles to prevent the weighted cone from slipping out the vaginal opening.

Pelvic floor muscles will fatigue easily therefore high frequency short duration contractions are pertinent to increasing strength and preventing fatigue.[40] Initially the female should contract the muscles for two seconds and relax for two seconds repeating six to ten times. The six to ten repetitions should be performed several times throughout the day leading up to 100-120 contractions per day. As endurance increases, the female can hold the contraction for four to six seconds. A quick one second contraction should follow each sustained contraction followed by the relaxation phase.

It is estimated that 30-50% of women perform pelvic muscle exercises (PME) incorrectly which could worsen the risk of leakage or expend unnecessary energy on inefficient contractions.[42] Because the pelvic floor muscles are not visible or routinely used, they can be difficult to isolate. Errors frequently involved are performing the valsalva maneuver or holding the breath. Attempting to bear down is another problem which strains the pelvic floor muscles downward instead of drawing them upward. Substitution of other muscle groups for the pelvic floor can lead the female to think she is performing the exercises properly and achieving a strong contraction. The abdominal and buttock muscles may

contract instead. Contraction of the abdominal and buttock muscles while performing the pelvic exercises is acceptable but care must be taken to prevent substitution. Another muscle group that may substitute are the hip adductors.[6] This happens most frequently when the female is in the crossed-ankle position when she brings her thighs together (adducts) instead of contracting the pelvic floor. A common misconception is that the pelvic floor muscles are put on stretch when the legs are abducted such as in the position of tailor sitting, squatting, or sitting with knees pulled up and apart toward the ears. However, the pelvic floor does not attach to the femur, therefore, this position does not stretch the pelvic floor muscles. Actually, the exact opposite occurs; with the legs abducted the female will feel exposed and contract her pelvic floor muscles which may have beneficial effects. Therefore, the abducted position is beneficial in the strengthening of the pelvic floor muscles.

Feedback can be used to ensure proper muscle contraction. This can be accomplished when urinating by stopping the flow of urine. However, this should not be performed when the female has a full bladder such as in the morning or if she has a urinary tract infection.[6] This activity can be performed to check if she is contracting the correct muscles and if the contraction is strong enough to stop the flow of urine. This may be discouraging if the female does not have a strong enough contraction to stop the flow of urine, in which case another form of feedback is needed. Another form of feedback includes placing two thoroughly cleansed fingers in the vaginal opening with fingers slightly apart. Contracting

the pelvic muscles will push the fingers together and the female will know she is performing the exercises correctly. Biofeedback can also be utilized to assess strength of the pelvic floor muscles contraction.

CHAPTER 5

CONCLUSION

The growing interest for females to participate in exercise and sporting activities during pregnancy has led to the need for research. Research has examined responses of the mother and fetus to various types, intensities, and durations of exercise. However research continues to be controversial, contradictory, and limited in the number of subjects participating.

Limitations with prenatal exercise research include liability from unnecessary harm to the mother or her unborn child; many women are hesitant to participate in research because of the fear of harming their child. Limited research is available to determine maximum intensity and duration of exercise along with whether certain strenuous activities can be performed without having detrimental effects to the mother or fetus. Research is being performed on elite athletes who wish to continue to train for competition at high exertion levels while pregnant. Animal research is also being performed to determine physiological responses to high levels of exercise. Research performed on pregnant elite athletes and animal studies has helped in the establishment of guidelines for maximum parameters a pregnant female can exercise at.

Studies have been conducted to help determine female and fetal cardiovascular, thermoregulatory, musculoskeletal, and respiratory responses to exercise which have enabled organizations such as the American College of Obstetrics and Gynecology to set exercise guidelines for the pregnant population.[3,4] These guidelines consist of recommendations for exercise frequency, duration, and intensity. They have also addressed environmental, nutritional, and musculoskeletal concerns along with various diseases and complications in pregnancy that may require the pregnant female to cease exercising or modify her exercise regimen. In the past, specific parameters have been established as maximum intensity and duration of exercise. Recently these limitations have been removed because of criticism that the guidelines did not take into account the female's age or fitness level prior to becoming pregnant. A female at a higher fitness level prior to pregnancy can exercise at a higher intensity and for longer periods of time than a sedentary female initiating an exercise program.

The exercise program must be individualized to meet the female's needs and goals and should be based on fitness level, monitoring signs, symptoms, and complications which may occur throughout pregnancy. Females will need to alter their exercise program as pregnancy progresses; many woman will decrease the intensity and duration of exercise along with modifying the type of activity they participate in. It is very important for the pregnant female to seek a medical evaluation before initiating or continuing an exercise program.

Specific exercises have been determined to help alleviate or prevent complications that may occur during pregnancy and help the female deal with changes her body goes through during the course of her pregnancy.[6,8] These exercises prepare the female for delivery and the postnatal period along with increasing the rate of return of the female body to the pre-pregnancy condition.

A physical therapist needs some basic knowledge of pregnancy and exercise when evaluating and treating an obstetrical patient. It is important to understand the physiological changes the female body goes through during pregnancy and how these changes affect her ability to exercise. The pregnant female will respond differently to exercise than a female who is not pregnant. An awareness of fetal and maternal responses to exercise is also needed. These will affect how the patient is treated and progressed along with how she responds to therapy. A thorough history of the female's pregnancy and fitness level is needed to determine if there are any complications which may require modification of treatment or her exercise regimen or if complete cessation of exercise is necessary. Knowledge of specific positions and exercises that must be avoided during pregnancy is important. There are common musculoskeletal problems that may occur during pregnancy including lumbar, abdominal, and pelvic floor pathologies. Knowledge and recognition of these problems and exercises the pregnant female needs to perform to prevent or alleviate these problems are beneficial when treating pregnant females.

Research has enhanced knowledge and answered many questions and concerns regarding the ability to exercise during pregnancy. Various forms of exercise have been determined beneficial and some harmful for the female and fetus. Research has helped to determine exercise guidelines and parameters for the pregnant population, however there are many questions left unanswered. With the growing interest in prenatal exercise, many of these unanswered questions will need to be examined.

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